LPSC XXV
N94-16375

SUGGESTION FOR EXTENDED VIKING MAGNETIC PROPERTIES EXPERIMENT ON FUTURE MARS MISSIONS

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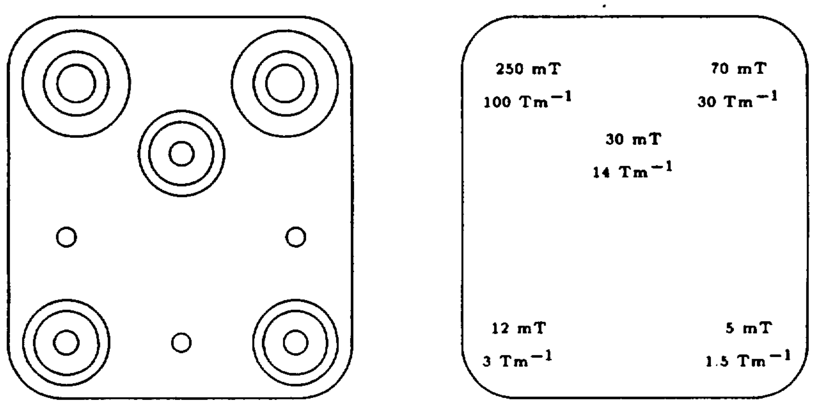
An array of permanent magnets, with the purpose of establishing if the magnetic particles on Mars are present as discrete or as composite particles, has been constructed.

Introduction: A remarkable result from the Viking missions was the discovery that the Martian soil is highly magnetic, in the sense that the soil is attracted by a small magnet [1]. The soil was found to adhere almost equally well to a strong and a weak SmCo magnet in the Viking lander backhoe at both landing sites. The strong magnet had a magnetic field and field gradient of 0.25 T and 100 Tm^{-1}, respectively, whereas the corresponding values for the weak magnet were 0.07 T and 30 Tm^{-1}. Besides the backhoe magnets the Viking landers also carried a strong magnet situated at the Reference Test Chart (RTC). This magnet was exposed solely to the airborne dust. The RTC magnets of both landers attracted a substantial amount of airborne dust. Based on the pictures returned of the soil clinging to the magnets, it was estimated that the particles in the Martian dust contain between 1% and 7% of a strongly magnetic phase, probably a ferrimagnetic oxide intimately dispersed throughout the soil. Chemical analyses by means of the Viking X-ray fluorescence spectrometer indicate a content of about 18% by weight of Fe_2O_3. The limits of the saturation magnetization, σ, of the soil may be given approximately as: $5\ Am^2(kg\ Fe_2O_3)^{-1} < \sigma < 38\ Am^2(kg\ Fe_2O_3)^{-1}$. A significant observation was that both the weak and the strong backhoe magnets were essentially saturated with magnetic soil throughout the whole Viking mission. The results were the same for both landing sites. A notable result was that the dust on the RTC magnets, the dust on the backhoe magnets and the dust on the surface of Mars were optically very similar, if not identical. It seems that the attracted airborne dust and the attracted surface dust were of the same composition and probably also in the same grain size range.



Array of 5 permanent magnets. The three smallest circles represent measurement posts, casting shadows that are used to estimate the amount of material on the array.

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An essential problem that was not definitively solved by the Viking Magnetic Properties Experiment is the following: Is the magnetic phase in the Martian soil present as discrete (single phase) particles or is the magnetic phase part of composite (multiphase) particles? The objective of the experiment suggested here is to contribute to the solution of this and other problems related to the study of the magnetic phase on Mars.

Experimental: We have produced various prototypes of permanent magnet arrays, including weak magnets. As an example we show an array consisting of 5 permanent magnets.

When mounted the magnets are imbedded in a magnesium panel. The mass of the panel is 70 g. The dimensions are $67 \times 60 \times 9$ mm^3. The fields and field gradients on the surface of the panel are given in the figure.

Discussion: Tests with various Mars soil analogues have shown that inclusion of low strength magnets will give additional information about the magnetic properties of the Martian dust. For example: Dust composed of pure maghemite (γ-Fe_2O_3) will stick to all five magnets. Dust composed of thermally altered nontronite, which contains a small amount of maghemite, will stick only to the two (three) strongest magnets. The thermally altered nontronite is an example of composite multiphase particles. By studying the amounts and colour of the dust adhering to the various magnets, and the interaction of the dust on the array with the wind, we may come close to determining the magnetization of the particles adhering to the magnet array. A complete identification of the magnetic phase will probably not be possible.

It is under consideration to include a Mössbauer spectrometer in future missions to Mars [2,3]. It will be demonstrated that the array of magnets will give significant contributions to the interpretation of Mössbauer spectra of the Martian soil.

Conclusion: It is suggested that future missions to Mars carry permanent magnet arrays that include several weaker magnets as well as the types of magnets carried by Viking. If the landers - for other purposes - carry also a magnetometer, the magnet array should consist of 4 (not 5) magnets. The four magnets should be arranged in such a way that the magnetic field far from the magnet array decrease at least as a quadrupole field. In this way the magnet array will not interfere with the measurements of the magnetometer.

Acknowledgement: Financial support from the Danish Natural Science Research Council is gratefully acknowledged.

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